New Astrometric Measurements for WDS 12023+7222

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Abstract

Using the Great Basin Observatory (GBO), the Global Astrometric Interferometer for Astrophysics (GAIA), and The Washington Double Star Catalog (WDS), we gathered data relating to WDS 12023+7222 on February 1, 2020. Included in this data is magnitude, distance, proper motion, angular separation, and position angle of the two component stars. Our objective was to characterize the gravitational interaction between the components of WDS 12023. We suggest that the components are not physically associated, and though a linear solution exists, they are not a common proper motion pair. We conclude that WDS 12023 is not a binary star.

Image 1: The Great Basin Observatory, located in Great Basin National Park, Nevada.

1. Introduction:

The Great Basin Observatory (GBO) is the first research telescope built in a National Park, located in Great Basin National Park, Nevada. SUU students have priority access to data from the GBO. The GBO houses a Planewave CDK 700 telescope in a clamshell dome, which is remotely operated. Out target star, WDS 12023+7222, is a system first measured in 1831 and last measured in 2017 with a total of 100 observations. It is a system with two components, consistent data, numerous data points, a linear solution, and a separation large enough to resolve, making it an ideal target for our observation. Our objective was to add another valuable data point to the WDS, to characterize the sum of the data collected thus far, and to develop a double star research program for students at SUU to follow using the GBO.

2. Equipment and Methods:

Images for this project were taken using the GBO, which is maintained by the Great Basin National Park foundation in collaboration with four universities: Southern Utah University, Concordia University,

University of Nevada, and Western Nevada College. GBO has a robotic Planewave CDK 700 telescope with an aperture of 27 inches and a focal ratio of f/6.5, a SBIG STX 16803 camera with a field of view of 27x27 arcminutes and a plate scale of 0.4 arcseconds per pixel. It is also equipped with sixteen filters, including LRGB, Ha, OIII, SII, BVRI, and a diffraction grating. Our data was requested and taken remotely. Due to its location in a national park, the GBO has excellent dark skies to make nightly automated observations, and services several research projects at once. Students at SUU have priority observation time, allowing access to professional data to undergraduate projects.

We observed WDS 12023+7222 on one night on Julian date 2020.0876. As of the previous observation in 2017, the initial position angle was 34.2° and the initial angular separation was 11.73". In order to avoid saturated pixels, we took a total of 20 images at 30 second exposures. All images were taken with a visual (V) filter, and calibrated by applying dark, flat, and bias frames. The images were then plate-solved, corrected, and measured in AstroImageJ, a free, open-source software for astronomical measurements and photometry (Collins, 2017). The correction process reduces noise and hot pixels inherent in any telescope and camera, and plate solving converts the (X,Y) coordinates of the images to the right ascension and declination in the World Coordinate System. AstroImageJ located the centers of the two components and measured position angle (θ), angular separation (ρ), and change in magnitude, as seen in Table 1. This measurement was done for all 20 images; averages, errors, and standard deviations were calculated as seen in Table 2.

For our historical data, we used The Washington Double Star Catalog (WDS). The WDS is the principal database for double star information and is maintained by the United States Naval Observatory. Historical Data for the stars was requested for comparison with our new astrometry measurements. The first observation of WDS 12023 was made in 1831, the most recent in 2017, with a total of 100 observations. A selection of the historical data is made in Table 2.1. Distance data for our target was provided by the Aladdin Sky Atlas software using data from the GAIA sky survey, which was used to help characterize the interaction between our target stars (Gaia Collaboration, et al., 2020a). As detailed in Table 1, we measured the magnitude of the primary star to be 9.21, the change in magnitude to be 0.60737, the new position angle to be 32.849°, and the new separation to be 11.674".

3. Data:

Table 1. WDS 12023 Data

WDS #	Discoverer	Julian Date	# of Images	Delta Mag.	θ(°)	ρ(")
12023+7222	STF	2020.0876	20	0.60737	32.849	11.674

Information on our images of WDS 12023+7222, including date, delta mag, separation, and position angle

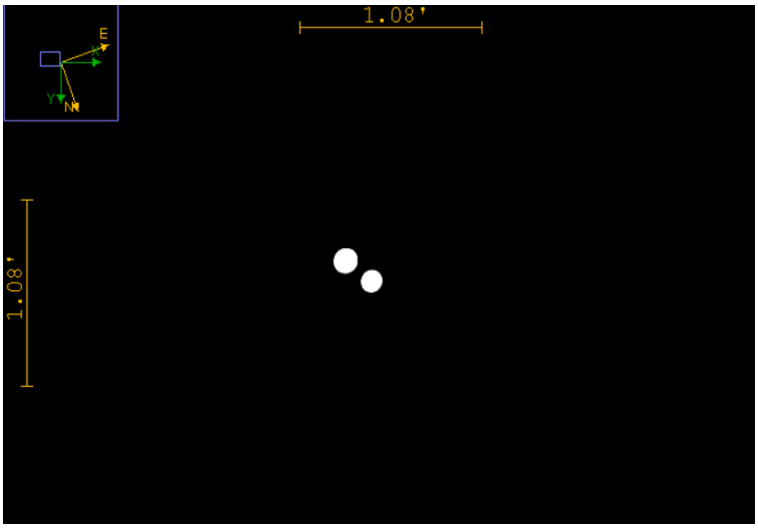
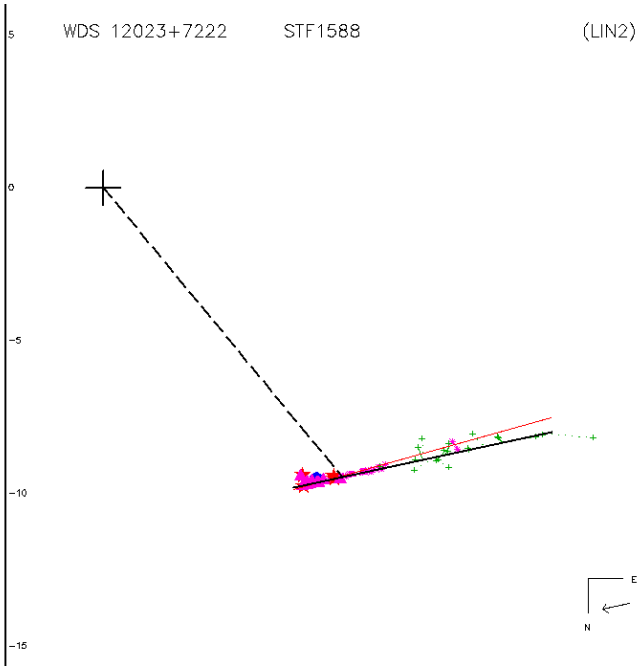


Image 2: Components of WDS 12023; A (upper left) and B (lower right) of WDS 12023, as seen in the AstroImageJ software

Table 2. WDS 12023 Data Cont.

	θ(°)	ρ(")
Mean	11.673702	32.8487562
Std. Dev.	0.01864728895	0.02024238563
Std. Error	0.004169660569	0.09052670059

Further information about our measured separation and position angle of WDS 12023, including mean, standard deviation, and standard error



Graph 1: WDS historical data above shows a linear solution for WDS 12023 and suggests that the components may be a common proper motion pair. Further data in Table 3 tells otherwise.

Table 2.1. WDS Historical Data

Year	θ(°)	ρ(")
1831.59	60.7	16.49
1912.28	50.9	14.13
1961.27	43.64	12.794
1999.93	36.9	11.98
2017.196	34.2	11.738
2020.0876	32.849	11.674

A selection of historical data for WDS 12023, from the first observation in 1831 to our observation in 2020. Notice the steady, decreasing trend of both the position angle and separation.

Table 3. Gaia Data

Components	Parallax [milliarcsec]	Distance [lightyear]	Proper Motion RA [milliarcsec /year]	Proper Motion DE [milliarcsec /year]	RUWE
A	1.78 ± 0.012	1831 ± 12.23	24.396 ± 0.015	3.149 ± 0.0154	1.044
B	4.21 ± 0.013	775 ± 2.31	-18.555 ± 0.018	13.210 ± 0.0163	1.123

Distance and Proper Motion data taken from the GAIA database using the Aladin Sky Atlas software. In conjunction with Graph 1, we can conclude that WDS 12023 is not a common proper motion pair.

4. Discussion

A measure of the accuracy of GAIA data is given as the re-normalized unit weight error (RUWE; Lindegreen 2018), with ideal data being close to 1.0. Our GAIA data was given a RUWE fairly close to 1.0, as seen in Table 3, so we can reasonably trust the distances and proper motions given for each star. As seen in Graph 1, the component star B appears to have a partial orbit or linear relation with the primary star A, but distance data given in Table 3 puts B at about 1056 ± 14.54 lightyears away from A. Further, the components differ in proper motion by at least RA: 42.447 mas/yr and DE: 9.883 mas/yr. Taking the GAIA data in conjunction with the historical data, we conclude that A and B do not have any substantial gravitational interaction and are not a common proper motion pair.

5. Conclusion

For the double star WDS 12023+7222, historical data suggests a possible orbit of component star B around the primary star A, but distance data from the GAIA database places these stars more than a

thousand lightyears apart. Gravitational interaction between stars A and B is not possible. A linear solution is indicated in the WDS catalog, using more than one hundred data points, but GAIA data gives radically different proper motions for the two stars, indicating that this is not a common proper motion pair. We conclude that WDS 12023+7222 is not a binary system.

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